UC Agriculture & Natural Resources
Proceedings of the Vertebrate Pest Conference

Title
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Permalink
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Journal
Proceedings of the Vertebrate Pest Conference, 6(6)

ISSN
0507-6773

Author
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Publication Date
1974

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THE ASSOCIATION OF THE ROOF RAT (Rattus rattus) WITH THE HIMALAYAN BLACKBERRY (Rubus discolor) AND ALGERIAN IVY (Hedera canariensis) IN CALIFORNIA

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ABSTRACT: The roof rat (Rattus rattus) utilizes Algerian ivy and the Himalayan blackberry for food and cover, often living independent of man. Algerian ivy is the most popular ornamental and ground cover plant in California and is used extensively for landscaping, particularly in southern California. The Himalayan blackberry inhabited by feral roof rats, grows abundantly in northern California along inland creeks and in pasture land of the Sacramento Valley and in the foothills of the Sierra Nevada. Rats construct platform nests on or within the dense layer of canes that accumulate within the thickets. Information on distribution and recommendations for the control of the roof rat within the blackberry habitat are presented. A potential human plague threat exists where rodent cohabitants of the berry thickets may become involved in epizootics.

The roof rat (Rattus rattus) is principally an outdoor species in California as it is in most parts of the world and its role here is primarily that of a pest. It is commonly found living in association with Algerian ivy (Hedera canariensis) in southern California, and with the Himalayan blackberry (Rubus discolor) which grows wild in northern California. In both situations the roof rat is able to obtain the necessities of life without supplementary food or cover. Both plant species are important not only because they supply food and cover for rats but because of their overabundance and widespread distribution.

It should not be surprising to find the roof rat living independent of man inasmuch as this species probably experienced an earlier period of development in an Asian habitat that possesses some of the characteristics of both the Himalayan blackberry and Algerian ivy.

ROOF RAT COLLECTIONS IN CALIFORNIA

The currently known distribution of the roof rat in California is shown in Figure 1. , Collections from coastal and inland southern California are primarily from residential areas heavy with Algerian ivy and other ornamental plantings. However, in northern California, including the Central Valley, roof rats are primarily associated with the Himalayan blackberry. Thus the distribution of this plant and its tendency to form large, dense thickets become of primary importance in determining roof rat occurrence.

ALGERIAN IVY--ROOF RAT ASSOCIATION

The roof rat--Algerian ivy association presents a major problem in many areas. In Los Angeles County over 75% of the rat complaints (including Norway rats) received by the County Health Department concern roof rats living in Algerian ivy (J. C. Ruddock, personal communication). In the San Francisco Bay area, ivy is responsible for a substantial number of residential roof rat infestations, but the problem becomes progressively less significant northward where colder winters tend to restrict its growth.

Infestation rates of 25-50% occur in yards of some newer tract neighborhoods that are set amidst former orchards and 20-30% in older residential areas with heavy shrubbery. After about 10 years, trees and shrubbery have usually become sufficiently dense for roof rat habitation and often by the 15th year a chronic problem has developed (Brooks, 1966).

Rampant wild growth of Algerian ivy has not become a problem as it is dependent upon a constant water supply for its survival and grows primarily in managed situations. A future problem could, however, develop around permanent water sources.

Vertical growths of ivy along fences or walls are excellent avenues for movement in a neighborhood or premises. Our records indicate heavy use of vertical growths of ivy for nesting and feeding with additional use of adjacent flat or sloping surfaces for feeding, particularly under shrubbery or tree branches that offer some concealment. Although Algerian ivy is capable of supporting roof rats by itself, a variety of man-made harborages are sometimes more readily accepted. Some favorite sites are firewood piles, pyracantha shrubs, date palm trees, honeysuckle vines and many other dense growth ornamentals.

While roof rats will take available water, sufficient moisture apparently is present in the central tissues (pith) of the ivy vine and in fruit that is eaten. Pith is removed from the vine by first splitting off a section of the vine and then by scraping it out with the incisors. Other foods are unharvested fruit or nuts, garden vegetables, bird eggs, and invertebrates such as snails, spiders and earth worms. Pet food is often available and is a constant problem as an attractant.

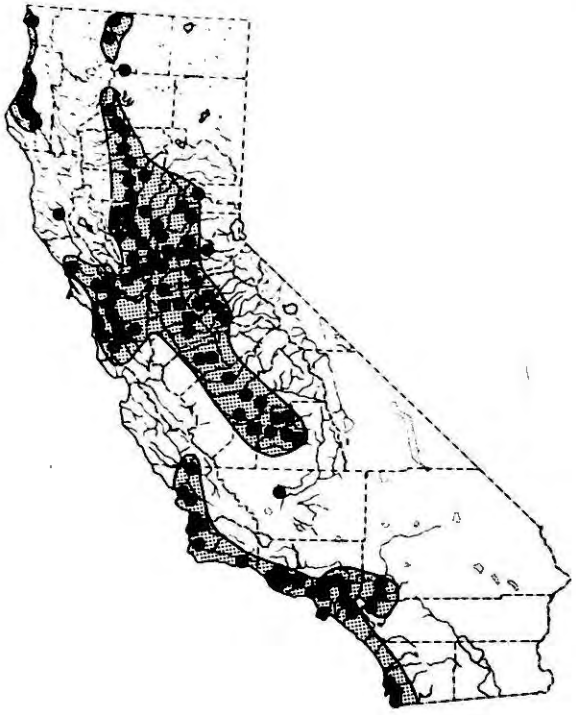

Figure 1. Distribution of the roof rat in California. Dots represent one or more collection sites. Shaded areas are where roof rats are likely to occur. Information was taken from Vector Control Section records, California State Department of Health.

THE HIMALAYAN BLACKBERRY IN CALIFORNIA

The Himalayan blackberry was introduced into this country by Luther Burbank in the early 1890's from seeds obtained from the Himalaya Mountains (Bailey, 1915). This blackberry is native to Europe, parts of Asia, and North Africa and is now widely spread throughout the world (Leonard, 1968). By 1915 this berry was being grown commercially throughout the United States.

The Himalayan blackberry can be recognized by leaves having 5 leaflets and by the ribbed stems or canes that are sterile the first year (primocanes). During the second year these canes develop fruit (becoming florocanes) and have leaves with 3 to 5 leaflets (mostly five). The native wild berries have 3 leaflets and canes are not ribbed. The large, succulent drupelets dry on the torus, making fruit available for rodents and birds throughout the year. Prickles are 1/8 inches to 1/2 inches long, reflexed on florocanes and are strong enough to repel large animals, thus providing excellent protection for the roof rats living within the thicket. For a more complete description refer to Munz (1959). Rubus discolor grows rapidly in favorable conditions, spreading 20 to 50 feet in a growing season (Bailey, 1915) and having canes as long as 22 feet.

The plant was cultivated for its edible fruit, but it escaped and has become a serious weed pest in northern California, western Oregon, and Washington. In California, the Himalayan

blackberry is so common in some areas that it appears to have invaded every tolerable site (Figure 2). It thrives below 3000 to 5000 feet where soil moisture is available, but it is excluded from higher or colder areas, such as the Great Basin region of the northeastern section of the state.

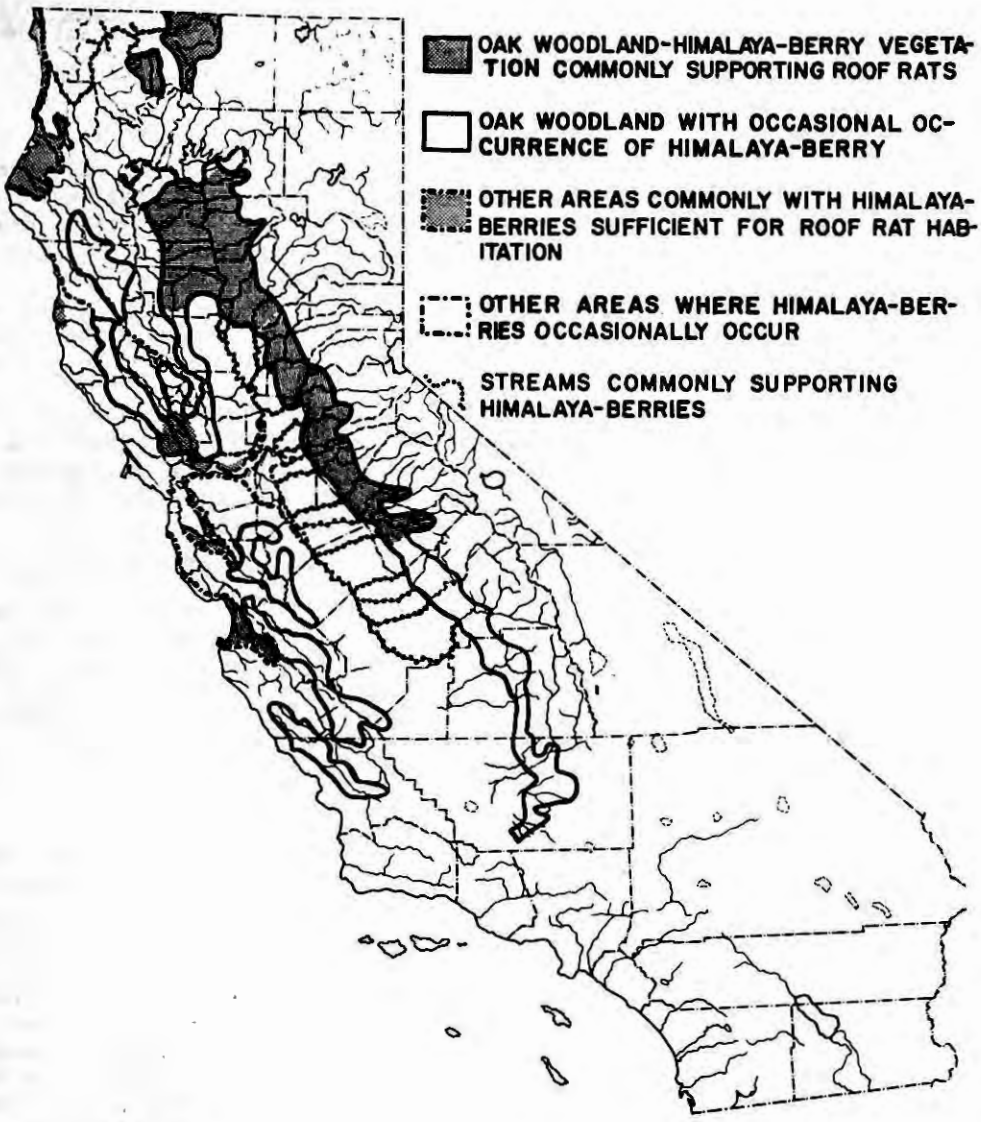

Figure 2. Himalayan blackberry distribution in California.

R. discolor invades existing plant communities through disturbances caused by logging, cultivation, irrigation, road construction, and other activities. Throughout the oak woodland plant community of the northern coastal mountains east of the redwood belt, the Himalayan blackberry does very well along stream banks and on pasture land with adequate moisture. This berry is abundant in pastureland of the northern Sacramento Valley and along all streams that finger out onto the valley floor from the Sierra Nevada foothills. In the northern foothills, thickets occupy a large amount of grazing land, however, thickets become progressively more sparse in growth form and distribution to the south in both the foothill country and in the Central Valley. In the San Joaquin Valley, R. discolor becomes less common owing to more arid conditions. This moisture requirement allows growth only at higher elevations in the Sierra Nevada foothills. Thickets rarely occur on the west side of the Central Valley due to extremely dry conditions.

The Himalayan blackberry is quite common in the suburban and urban areas along the central coast, particularly in the San Francisco Bay and Monterey Bay areas. Again, however,

it becomes rare in the southern California coastal section because there are very few favorable growth sites.

Blackberry distribution on the seaward exposure of the north coast is unlike that found elsewhere in the state. On the north coastal slope, Himalayan blackberry is common in towns and in cultivated fields and farm yards. Unlike the interior regions, coastal streambanks generally do not support the Himalayan blackberry. Characteristic flora of the coastal streams include the native blackberry (Rubus vitifolius), salmon berry (R. spectabilis), big-leaf maple (Acer macrophylum), and red alder (Alnus rubra). In this habitat the dense shading appears to be an important factor in excluding R. discolor.

ROOF RAT--HIMALAYAN BLACKBERRY ASSOCIATION

The Himalayan blackberry readily climbs, often shading out bushes and small trees 10 to 15 feet high. Without support, berry brambles commonly reach 6 to 8 feet, with occasional thickets as high as 10 feet. Such vigorously growing thickets develop layers of dead canes and leaves at a point where the supporting canes cross. As the thicket matures, the layers become thick and after a few years the materials eventually coalesce from the weight creating a single dense, thick layer. These accumulations or mid-layers of canes and leaves are used as nesting sites by roof rats. Although it is difficult to establish age of a thicket, approximately 8 years are required for layering to develop sufficiently to provide harborage for roof rats.

In shaded areas, canes grow sparsely within the thicket and the dead canes and leaves do not become trapped and midlayers are not formed. Therefore little or no nesting cover is available. Moreover, the open growth form exposes the roof rat population to more predation. The importance of vigorous growth form to the incidence of rat habitation was determined from surveys conducted in the Sierra Nevada foothills from January 1965 through December 1972.* Of 39 thickets surveyed by snap-trapping, 20 (51%) were positive for roof rats. The actual rate of infestation was higher, as in several instances, roof rat sign was evident or the traps were sprung. Growing conditions that support pine trees are apparently not sufficient to produce vigorous growths of Himalayan blackberry. In contrast, thickets associated with oak trees grow vigorously. Thickets growing near yellow pine (Pinus ponderosa) had a 29% infestation rate, with a trapping success of 5.8% for 315 trap nights. In areas where thickets were associated with oak (Quercus douglassi and occasionally Q. wislezenii) the infestation rate increased to 72.7% and the trapping success reached 14.5% for 398 trap nights.

The structure of the Himalayan blackberry thicket not only protects the roof rat from predators, but, in addition, it protects them from adverse weather. Temperature and humidity were recorded inside and outside of blackberry thickets growing at 1000 feet elevation and occurring within favorable growth conditions of the northern Sierra Nevada foothills near Auburn, California. Recordings were taken at ground level (3 inches above ground) and at 6 feet above ground both inside and outside the blackberry thickets. Winter temperatures (Figure 3) at ground level averaged 7° F warmer inside than outside the thicket between 10 p.m. December 26 and 8 a.m. December 27, 1972. During the summer (Figure 4) temperatures at the ground level averaged 16.1° F cooler inside the thicket between 4 a.m. June 6, and 6 a.m. June 7, 1973. The locations for determining temperature and humidity were the same for both winter and summer. The outside hygrothermographs were kept completely shaded without restricting air movement during the summer recording. The Himalayan blackberry thicket provides good protection during cold and hot weather, particularly if layering has developed. Relative humidity during the winter check was 100% outside the thicket under foggy conditions and 86% inside the thicket. Relative humidity during the summer averaged 61.5% inside the thicket and 43.1% outside. Utilization of this habitat may enhance retention of the rats body water during the dry summer and fall seasons.

An all-time record freeze occurred during December 1972, killing, to the ground, all thickets of the Himalayan blackberry and the few thickets of the evergreen blackberry (R. laciniatus) in the Shasta and Scott Valleys of Siskiyou County in northern California. The freeze lasted 12 days and included 5 days that averaged -8.6° F. These thickets sprouted vigorously during the summer of 1973, and it is estimated that they will reach previous growth and form by the end of the 1974 growing season. Roof rats either died from the cold or found shelter in nearby homes as was determined by subsequent trapping.

*Survey data compiled by Eugene J. Sherman, Joe E. Brooks, Val J. Dutson and Kenneth H. Hansgen.

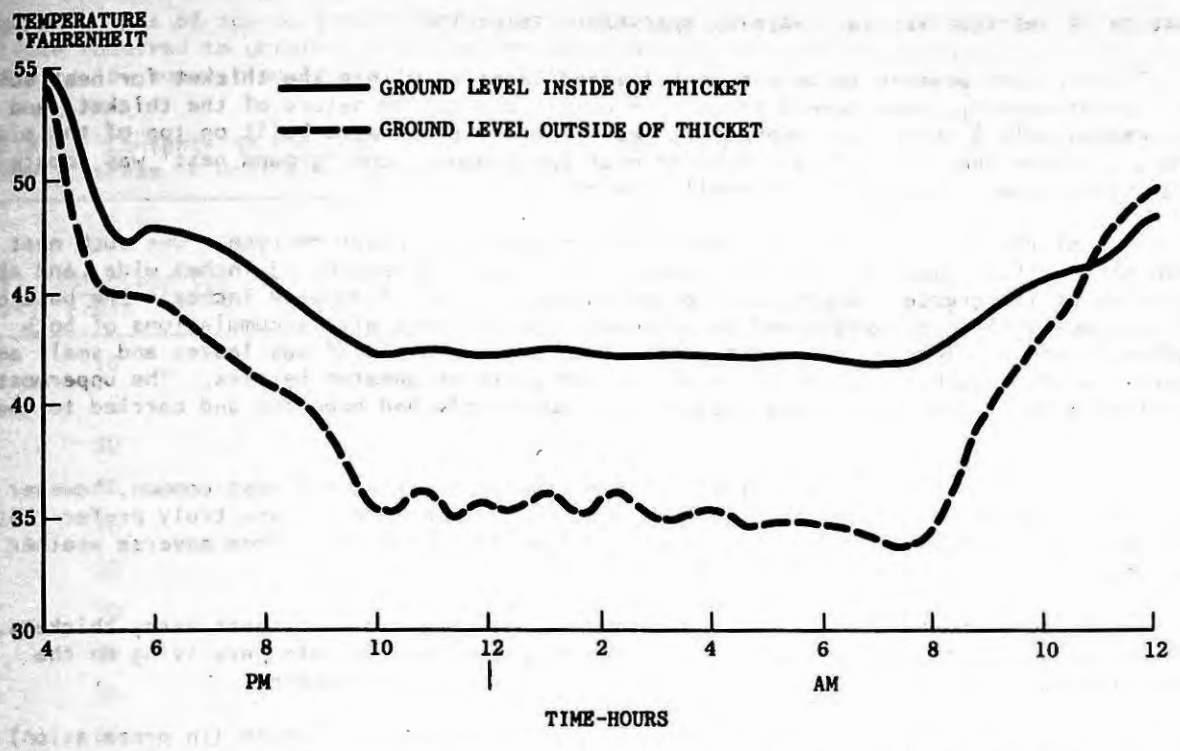

Figure 3. Winter temperature recordings from inside and outside of a Himalayan blackberry thicket.

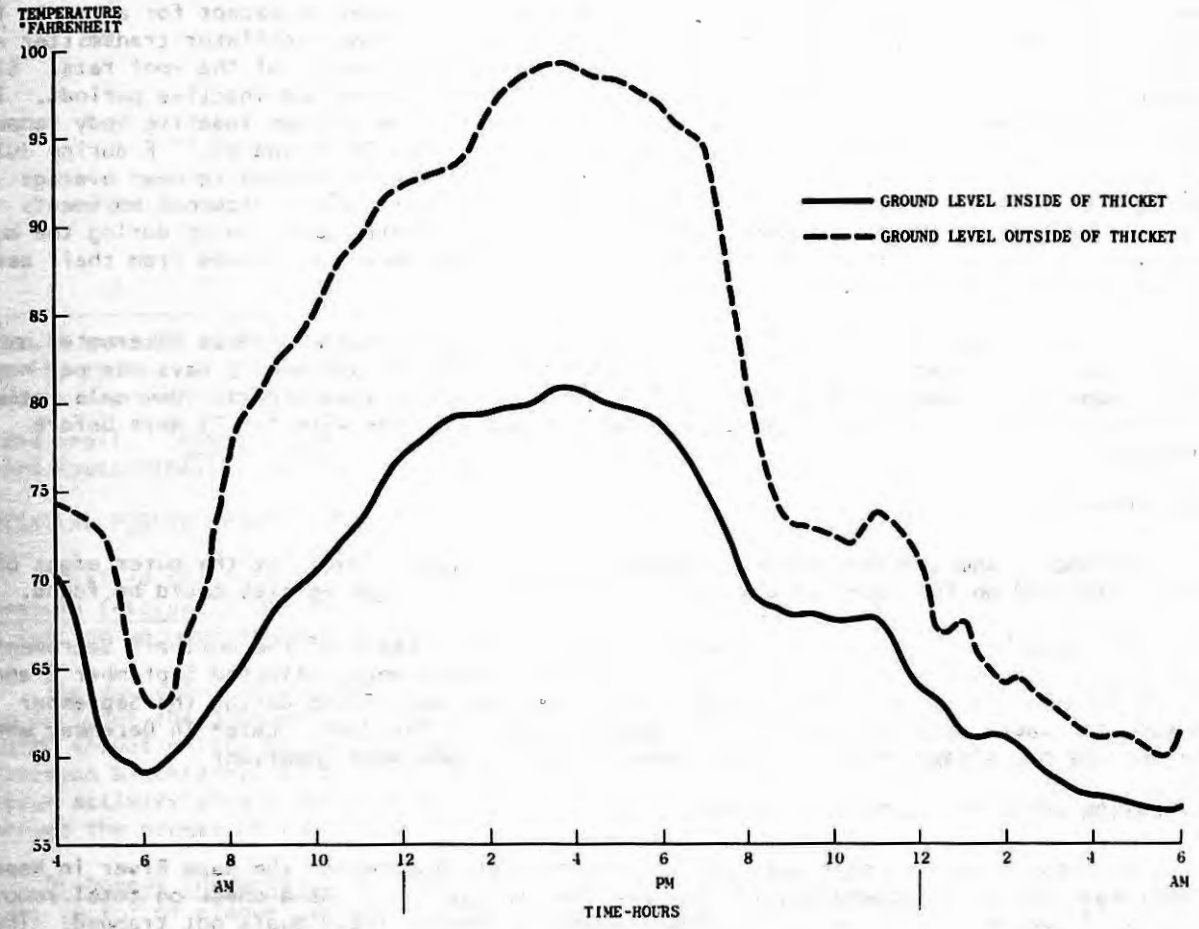

Figure 4. Summer temperature recordings from inside and outside of a Himalayan blackberry thicket.

The midlayer appears to be the most favored location within the thicket for nest building. Unfortunately, nests are difficult to obtain due to the nature of the thicket, and for this reason only 8 nests have been described. Four of these were built on top of the midlayer, 2 within the midlayer, and 2 on or near the ground. One "ground nest' was located in a 1-gallon can, the other on a small pile of posts.

In 5 of the 8 nests observed, the construction was of platform type. One such nest taken from a study site was oval and measured 16 inches in length, 13 inches wide, and about 10 inches at its greatest depth, with a central depression of about 4 inches. The base of this obviously old nest originated on a dense layer of canes with accumulations of both blackberry and oak leaves. The nest material consisted mainly of oak leaves and small amounts of grass stuck together with fecel droppings and parts of uneaten berries. The uppermost nest-lining consisted of green oak leaves that apparently had been cut and carried to the nest.

Based on these findings, nesting on top of the midlayer is the most common, however observation of additional nest sites is necessary to determine if rats truly prefer that location. Nests above the midlayer appear to offer less protection from adverse weather than those inside the midlayer.

Burrowing by roof rats for nesting cover was not observed in or near berry thickets. However, burrowing may occur where litter such as posts, boards, etc., are lying on the ground inside a thicket and where no midlayer is available for nesting.

A biotelemetry study was conducted by V. J. Dutson and C. R. Smith (in preparation) involving 8 roof rats inhabiting a Himalayan blackberry thicket in the northern Sacramento Valley. The study revealed that roof rats are gregarious in their nesting and feeding in this habitat. Established travel routes were used in their movements to and from nest sites, up and down trees and in moving from specific locations of resting and feeding within the thicket. Rats were generally active between sunset and sunrise except for a one to two hour period between 11 p.m. and 2 a.m. A small (2.4 g) blocking oscillator transmitter was calibrated to transmit temperature and implanted in the body cavity of the roof rats. Significant body temperature differences were observed between active and inactive periods. The average body temperature during activity was 100.0° F and the average inactive body temperature was 96.0° F during the cooler weather of March through April and 97.1° F during July and August 1971 (range 102.7° F to 92.0° F). Body temperatures dropped to near average during the nightly inactive period and immediately rose again during vigorous movements just before leaving the nest. Body temperatures reached their lowest point during the morning hours following the return to the nest. During summer days rats moved from their nests and selected cooler sites on the ground.

An interesting phenomenon of switching nest sites was observed. Rats alternated among as many as 5 different nest sites during tracking periods and averaged 9 days use per nest site. Some rats seemed to move from nest to nest more often than others. One male rat used 3 different nests in 24 hours whereas a female stayed with one site for 21 days before changing.

FEEDING HABITS

Feeding in the thicket occurred primarily on the ground level, at the outer edges of the thicket and on the upper canopy during the season when ripe berries could be found.

The stomachs of 20 roof rats (Table 1) taken from thickets of the northern Sacramento Valley were examined to determine diet. Fourteen stomachs were collected September 2 and six on December 15, 1970. Even though few ripe berries were found during the September period, they were still a consistently important part of the diet. Later in December when the berries had disappeared, pith and invertebrates became more important.

POPULATION NUMBERS OF ROOF RATS IN THICKETS

The total number of roof rats utilizing 3 thickets located on the Napa River in Napa County was studied by attempting to trap all the rats present. As a check on total removal of rats, flour was dusted on 1-foot square boards to detect individuals not trapped. The results (Table 2) indicate a rather low population in these thickets in that there was an average of 176 square feet of thicket per individual rat. However, about 30% of the berry

vegetation was of sparse growth form, due to shading. Further analysis of population levels will be required to obtain significant figures, however routine trapping surveys generally indicate low population levels unless a supplemental food supply is available.

Table 1. Contents of roof rat stomachs taken from Himalayan blackberry thickets bordering a small stream in northern Sacramento Valley.

Rat No.*	Percent of Contents									
	Blackberries			Unidentified Material						
	Fruit	Pith	Seeds	Plant	Other	Snails	Worms**	Arthro-pods	Canni-balism	Birds
1	10				10	80				
2	5				5	90[a]				
3	20			10	10				60[c]	
4	90				5			5		
5	10				20	5[a]		5		60
6	50		20		15			5		10
7	90								10[c]	
8	70			20			10			
9	50		20		30					
10	90				7			3		
11	15				10	15			60[c]	
12	20				10	5		5		60
13	20				18	20[b]	40	2		
14	100									
15		10	20		15	5[b]	40[d]	10		
16		50		10	30			10		
17				60						40[e]
18	5	20	20	10	30	15[b]				
19		20	15	30	20	10[b]	5			
20	5	20		40	30			5		

*Rats 1 through 14 were collected September 2, 1970 and 15 through 20 were collected December 15, 1970.
**Worms representing phylum Annelida.
[a]land snail [b]Physa [c]roof rat eaten in trap [d]15% of the 40% represents slugs
[e]bird (passerine) killed in trap and partly eaten

POTENTIAL PUBLIC HEALTH IMPORTANCE OF THE HIMALAYAN BLACKBERRY HABITAT

Possible transmission of bubonic plague bacteria among the native dusky-footed woodrat (Neotoma fuscipes), the roof rat, and man exists where the Himalayan blackberry has encroached into prime woodrat habitat that has a history of plague occurrence.

The dusky-footed woodrat, which is often involved in plague epizootics, occurs widely and includes the oak-woodland habitat within its range (Murray, 1971). A greater public health threat exists in residential areas where streams are overgrown with rat-infested Himalayan blackberry, as this is the only known habitat where both rats occur together. If plague activity should take place, the disease could be carried directly into nearby homes through the access of roof rats.

Orchopeas sexdentatus has been established as preferring Neotoma spp. and as an efficient vector of plague (Hubbard, 1947). The State of California Department of Health flea identification records confirm that O. sexdentatus is associated with N. fuscipes throughout its range and that O. sexdentatus does transfer from the dusky-footed woodrat to the roof

rat within this blackberry habitat. Additional data are needed to determine the level of flea transfer taking place to more accurately determine the degree of human risk. This aspect will be investigated further.

Table 2. Roof rats trapped or detected in 3 Himalayan blackberry thickets, Napa River, California, January 1972.

Thicket	Size (ft)	Total Trap Nights	Roof Rats Captured	Additional Rats Detected On Tracking Board
A	8 to 15 X 30	33	3 (1 adult male, 1 young male, 1 adult female)	0
B	20 X 30	34	2 (1 adult male, 1 adult female)	0
C	15 X 50	45	4 (1 adult male, 1 young male, 2 adult females)	1

RAT CONTROL IN THE HIMALAYAN BLACKBERRY THICKET

The only permanent rat control measure is the elimination of the blackberry habitat as thickets are a permanent potential source of invading rats. However, before removal of the thicket for any reason, rats should be eliminated.

Paraffin bait blocks containing anticoagulant poison are the best and safest means of temporary control. Anticoagulant poison minimizes the danger to children and pets, and the wax will prevent molding and deterioration of the bait.

Poisoning in the winter is most effective, as the population is low and food is scarce. Eight-ounce poison bait blocks with wire attached for easy inspection should be placed on the ground well inside the thicket. The bait site should be marked with a bright colored tag and the attached wire hooked near the marker. Bait blocks should be placed at least every 50 feet along the sides of wide thickets or along one side of narrow thickets, the type that is common along streams and drainage ditches. If all the bait is eaten by the rats after 2 days use, the amount should be doubled until a surplus remains. When it is determined that the bait is no longer being taken, it may then be removed. A community-wide project for the removal of the Himalayan blackberry should be undertaken for permanent control of roof rats, as thickets, where rats have been poisoned, will soon be reinfested.

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